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ABSTRACT

The relations among curiosity, intrinsic motivation, and the "flow" state of absorbed participation as defined by Csikszentmihalyi are explored. Specifically, the roles curiosity plays in triggering and maintaining a flow state in learners who are engaged in an interactive lesson are considered. There has not been much research on curiosity, but studies tend to confirm the presence of curiosity through observable and quantifiable behaviors. They suggest that its presence results in improved learning and performance, that it can be aroused, and that aroused learners will persist and be self-sufficient in pursuing learning goals. In interactive learning, curiosity would seem to have a central, although not completely understood, role. At its most basic, Csikzentmihalyi's flow state is simply a description of people enjoying themselves. It represents a desired state for those who create educational environments, including computer-assisted instructional environments. The flow state becomes a practical goal in computer-assisted instruction. (Contains 39 references.) (SLD)

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Curiosity, Motivation, and "Flow" In Computer-based Instruction

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Introduction

Computer-based learning systems, especially those which have as design goals a high degree of learner control, generally require a correspondingly high degree of motivation in the learners involved. As an important and long recognized element in learner motivation, curiosity thus becomes a significant concern for designers of highly interactive computer-based learning environments (Kinzie, 1990). However, the role that curiosity plays in the learning process seems so integral that its importance is often assumed. In recent research literature (with few exceptions) the term is either applied loosely or is subsumed into the general body of work on learner motivation, especially as it pertains to intrinsic motivation. With the exception of those investigators engaged in ongoing research with very young children, the work of Berlyne and Maw & Maw in the 50's and 60's remain the standard.

Recently Arnone and Grabowski (1992, 1993) have begun to investigate the role of curiosity in computer-based interactive video lessons. In addition, other investigators have continued to pursue more broadly empirical and theoretical work in curiosity, building upon Berlyne's seminal work in the field (Wohlwill, 1987). Of particular note to this paper is the work on "flow" experiences by Csikszentmihalyi (1975, 1990a; Whalen & Csikszentmihalyi, 1991). His work provides insight into the kinds of engagement experienced by learners whose curiosity has led them deeply into a lesson. In the light of these investigations and theorizing, this research paper seeks to investigate the phenomenon of curiosity in learners involved in a highly interactive, computer-based multimedia lesson.

This paper will examine the relationships between curiosity, intrinsic motivation, and Csikszentmihalyi's "flow" state of absorbed participation. Specifically, this study of the literature will investigate the possible roles curiosity plays in the triggering and maintenance of a flow state amongst learners engaged in an interactive lesson. Establishing a role for curiosity in flow states will, it is hoped, provide further insight into how this potent motivational tool can be better utilized by designers of instruction.

Background

In his often cited work Conflict, Arousal, and Curiosity (1960), Berlyne formalized curiosity as "exploratory behavior" and posed the existence of a number of kinds. Generally, he grouped them into two broad types. Included in the first type were those that were overt responses to external stimuli (or the lack of them) which he called "perceptual responses." The second type he termed "epistemic responses" and he typified them as being an internalized search for some of a number of kinds of knowledge by the person. He admitted these two types "may often coincide," clearly indicating the distinctions were for purposes of discussion and analysis alone (p. 80).

Berlyne (1960) saw organisms as continually seeking to maintain an optimum state of arousal and that exploratory behavior's purpose was to either boost or reduce an unacceptable level of arousal. In the case of epistemic behaviors, arousal was caused by a "conceptual conflict," a term Berlyne synonymizes with Piaget's "disequilibrium" (p. 220) and Festinger's "cognitive dissonance" theory (p. 283). He saw a search for knowledge as a search for the assuagement of a too high or too low state of arousal caused by some sort of conceptual conflict engendered by the person's mental or physical activities of the moment. "Epistemic curiosity" is the term Berlyne applies to the result of conceptual conflict occurring, and a search for knowledge is the behavior that results. The internalized nature of this stimulus-response-reward process places Berlyne's curiosity theorizing in the middle of almost any discussion of intrinsic motivation (Day, Berlyne, & Hunt, 1971; Deci, 1975; Keller, 1987).

The work of Maw and Maw (1964, 1965) centered on the detailed measurement of curiosity levels in individuals (children) and on classifying observable behaviors that

evidenced epistemic curiosity at work. They defined curiosity based on the presence of the following behaviors:

. When children--

1. react positively to new, strange, incongruous, or mysterious elements in their environment by moving toward them, by exploring them, or by manipulating them
2. exhibit a need or desire to know more about themselves and/or their environment
3. scan their surroundings seeking new experiences
4. persist in examining and exploring stimuli in order to know more about them

--they are being curious (1964, p. 31)

The labels "high curious-" and "low curious child" were then used to investigate possible correlations with such factors as socioeconomic status, parental attitudes, creativity, etc. In these pursuits they developed instruments that served to objectify the curiosity level of a child. Their definition has remained useful and is often cited to this day (e.g., Arnone & Grabowski, 1992; Day, 1982).

Many researchers since then have continued to explore the measurement-classification-dissection of exploratory behavior. Some researchers have tended to study curiosity (in children especially) alongside of "play," "imagination" and "creativity." Other theoreticians have grappled with the question of whether it is a "state" (i.e., a condition brought on by some stimulus or process) or a "trait" (i.e., a universal psychological need or drive). In his last work, Curiosity and Learning (left incomplete by his death in 1976), Berlyne (1978) repeatedly called for the development of a theory of motivation for explaining human behavior (as noted in Keller, 1987). That he did so in a work ostensibly about curiosity's role in learning reveals the inextricable relationship he saw between curiosity and motivational issues in learning.

Motivational psychologists mirror the divided opinions about curiosity outlined in the preceding paragraph. On the one hand, a divergence from the person's optimal level of arousal results in (motivates) behavior (called curiosity) which seeks to restore their arousal level (Berlyne, 1971). On the other hand, curiosity is seen as a result of "cognitive incongruence" for which persons "inherently" require corrective action in order to feel competent (Deci, 1975; Deci & Porac, 1978). The question, as before with the nature of curiosity itself, remains: Is intrinsic motivation a state, or a trait, of human existence? While there are areas of common ground between these two, theoretical discussion continues (Keller, 1987; Voss & Keller, 1983). In the meantime, those with a more practical bent have begun to apply some of this theorizing to everyday practice.

Csikszentmihalyi (1975, 1990a) has posed the existence of a state of human experience he calls "flow" wherein the individual feels (a) a merging of action and awareness, (b) the centering of attention on a limited stimulus field, (c) self-forgetfulness or loss of self consciousness, (d) a sense of control over one's actions and their environment, (e) the coherence and noncontradiction of demands for action and the provision of clear, unambiguous feedback from one's actions, and (f) an "autotelic" nature, i.e., the experience requires no goals or rewards to itself, (from Keller, 1987, p. 35). The internal nature of "flow" clearly places it, as a phenomena, well within the general arena of intrinsic motivation studies (Csikszentmihalyi, 1978). In addition, such an experience, fully realized, also represents a fair description of the desired state of a learner fully engaged in computer-based instruction, at least according to many interested in the development of such instruction (Keller & Suzuki, 1988; Kinzie, 1990; Lepper & Malone, 1987).

Curiosity and Instruction: Research

As has already been noted, there has not been much applied research done with

human subjects concerning curiosity and learning in the ages beyond the preschool years. Opinions and attendant theorizing about it are more common, but unless the topic involves motivation, curiosity is either broadly assumed or the research effort itself is concerned simply with recognizing, defining or measuring it (Boykin & Harackiewicz, 1981). In the case of Maw and Maw, whose work pioneered the field of curiosity measurement, their prescriptive conclusions summarized and reported later (Maw, 1971) remained very general: "If a school wishes to increase curiosity, so essential to learning, it must turn its attention to seeing that each child feels... worthy... of some importance... secure... accepted... loved," etc. (p.97) [emphasis added]. Harty and Beall (1984), answering the same call as Maw and Maw for useful curiosity measuring instruments, engaged in the creation of the "Children's Science Curiosity Scale." The test they developed went through six versions before settling on a 30 question instrument using a Likert type agree/disagree five point scale. They concluded that the instrument appears to be reliable and valid but cautioned that further testing with larger populations was needed before it could become a standardized tool for educators to use (they used less than 200 students overall).

With the notable exception of Berlyne himself, other research applying his theories of curiosity to actual learning situations (in humans) remains sparse or flawed (Koran, Koran, Foster, & Fire, 1989). An exception is the work of Boykin and Harackiewicz (1981). They were particularly interested in discovering how subjects, uncertain of their abilities to answer a question, would evidence curiosity as a response and, additionally, how their uncertainty would translate into later recall of the knowledge. The results confirmed the linear relationship between uncertainty and curiosity as those most uncertain expressed the highest curiosity. Also, the problems with the highest likely uncertainty (i.e., the most difficult) elicited the highest levels of curiosity. Subjects also tended to remember the most difficult words in the recognition test. The authors concluded that the supposed relationship of uncertainty to curiosity and of uncertainty/curiosity to retention was confirmed. The authors felt their methodology was sound and that their instrument could be used successfully for further investigations into curiosity.

Another example is the work of Inagaki where the author tested a number of hypotheses regarding curiosity, learner effort, and performance in science classes. In the first study (Inagaki & Hatano, 1977) (using fourth-graders) the treatment group (curiosity aroused) showed stronger desire for confirmation of a science experiment by observation, better generalization of the knowledge to other situations, and a higher correlation between performance and curiosity.

In another study (using kindergartners), citing the theory that highly curious children will interact more with their environments and thus gain increased mastery over it, Inagaki (1978) posed two hypotheses: (1) The higher the curiosity, the more actively the subjects will explore an experimental environment containing uncertain or dissonant elements; and (2) the higher the curiosity, the more measurable information the subjects will acquire, regardless of verbal ability. The results indicated a degree of correlation (but not a significant one) between curiosity and amount of exploration. High curiosity did correlate significantly with performance, even with verbal ability held constant, confirming hypothesis No. 2. The author concluded that curiosity (as a trait) played a significant role in learning. He goes on to predict that highly curious students will be more apt to have success in "student-centered learning," i.e. learner controlled environments.

The research reviewed here (obviously) represents only a sample of the empirical work done in the area. However, studies tend to confirm (a) the presence of "curiosity" through observable, quantifiable behaviors, (b) that its presence or activation results in improved learning/performance, (c) that it can be aroused by various instructional techniques, and (d) that aroused learners will persist and be self-sufficient in their pursuit of

learning goals (Day, 1982). Its psychological basis and attendant cognitive issues remain open to debate, however. As noted before, the work of neonatal and infant researchers is the cutting edge for this aspect of the field. For the rest, including those involved in creating computer-based interactive instruction, "curiosity" in all its theoretical and practical manifestations) remains an elusive target to hit, albeit an important one.

Curiosity and Interactive Instruction

Curiosity's role as a motivator in computer-based learning has been an object of interest for some time (e.g. Miller & Hess, 1972). Currently, curiosity figures prominently in the work of several important theorists within the field of instructional technology. J. M Keller's "ARCS Model of Motivation" (Keller & Suzuki, 1988) and Malone's "Taxonomy of Intrinsic Motivations for Learning" (1981; Malone & Lepper, 1987) each find a place for "curiosity" in their respective schemes meant to explicate the role of motivation in instructional design.

In the case of the ARCS model, Keller places curiosity in the "A" for "attention" part of his scheme. In this placement he emphasizes the ability of novelty, uncertainty, surprise, etc. to get attention (i.e., arouse curiosity). He hopes that the gaining of attention will be followed by engagement of the learner "in an inquiring frame of mind." This deeper engagement is epistemic curiosity, Berlyne's search for knowledge (Keller & Suzuki, 1988, p. 410). However, a close examination of the remainder of the model, Relevance-Confidence-Satisfaction, reveals those elements to also be elements in the curiosity theories posed by Berlyne and others. Novelty, et al., are insufficient arousal agents in and of themselves to insure the kinds of epistemic exploration we think of as learning. If the situation does not show promise of being useful, moderately non-threatening, and of being rewarding, we will not be led to explore it in any extended way. The entire ARCS model requires "curiosity" as a motivator for learning, at least as Berlyne (1971) would have it.

Malone's taxonomy poses a more comprehensive set of motivators than Keller. He, too, places curiosity in a separate category from the other catch words that make up his theory. In his discussion of it, however, he states, "In a sense, curiosity is the most direct intrinsic motivation for learning," and draws many parallels between it and the "challenge" element of the taxonomy (Malone & Lepper, 1987, p. 235ff.). In his first discussion of his theory he states, "In fact, challenge could be explained as curiosity about one's own ability, or curiosity could be explained as a challenge to one's understanding," (Malone, 1981, pp. 362-363). Clearly this relationship has much in common with the idea that curiosity's purpose is to assuage a perceptual or cognitive conflict, again from Berlyne (1960).

The point of this analyzing is to highlight the centrality of curiosity (at least as a full expression of Berlyne's curiosity theories would have it) to these two attempts at delineating the motivational underpinnings of computer-based instruction. Keller, especially, is limited in his appreciation of the comprehensive nature of curiosity in relation to the field of motivation. Perhaps Berlyne, the father of curiosity theorizing, was right in insisting, "A theory of motivation is indispensable if questions of performance are to be answered," (1978, p. 119).

In the work of Arnone and Grabowski (1992) mentioned earlier, empirical researchers have begun to address curiosity and its role in computer-based interactive instruction directly. In their study they focussed on how variations in learner control affected their subjects' curiosity and achievement. The researchers' concern was with the relative "amount" of curiosity demonstrated, similar to the Maw and Maw studies in the 60's.

The authors created a lesson on art museums using a computer controlled videodisc with a touchscreen monitor. The lesson was presented in three versions: (1) program controlled; (2) learner controlled; and, (3) learner controlled with advisement. 101 first and second graders from a public school were randomly divided into four groups, one for each

treatment, plus a base (control) group that received no instruction. After the treatments all groups took a posttest that measured achievement and three different curiosity measures: content exploration, questioning, and persistence, again using an interactive videodisc setup.

The results indicated that advisement resulted in achievement that was significantly better than without advisement, though no difference was found between these two groups and the program control group. All three treatment groups significantly outperformed the base (no treatment) group. In the curiosity measures, there were no differences in the "questioning" measure. Significant differences were found between the base group and the others in "persistence" with the base group persisting longer. A significant difference was also found in the "content exploration" measure between the base group and the advisement group with the the latter showing greater curiosity.

In their discussion the authors took interest in the fact that the learner control group's achievement was on a par with that of the other control options, possibly due to the content's inherent interest. They also found the non-instructed base group's high curiosity (as measured by persistence) indicative of their lack of prior exposure to the content-- it was all new to them and they took their time (the actual measure used) examining the stimuli during the posttest. On the other hand, the advisement group's greater curiosity (as measured by content exploration) than the non-treated base group represented the fruits of being instructed to "think" about the content during the instruction, thus making them more "intrigued" about museums in general.

While Arnone and Grabowski's work provides insight into how curious (or non-curious) subjects perform in interactive instruction, practitioners are more interested in how curiosity can be invoked in all subjects experiencing computer-based interactive instruction. Arnone and Grabowski (1993) have continued their work in this area specifically. On a broader front, Westrom and Shaban (1992) have applied Malone's work in a study comparing the motivational levels of players in "instructional" vs. "noninstructional" games. The authors found all of Malone's four factors (Challenge, Curiosity, Control, Fantasy) played roles in the initial and continuing engagement of the players / students. They concluded that a better understanding of motivational effects would lead to more effective instructional tools wherein students "might find that learning is, once again, fun," (p. 444).

While many factors have been posed as contributors to learner motivation in the field and several theories proposed (i.e., the Keller and Malone theories above), curiosity remains a difficult concept for most authors and researchers to deal with concretely in isolation. Like many of humankind's affects, it is easier to describe what it does than what it is. Perhaps we need to forego reductionist approaches and take up those that are integrative and holistic in their place. An example of such an approach follows next.

"Flow" and Interactive Instruction

Connecting the work of Csikszentmihalyi in the field of motivation theorizing to computer-based interactive instruction represents the final expository section of this paper. As can be seen from the summary earlier, his work lies with those researcher/theorists we classify as phenomenological or holistic in their approaches. As such, his work is probably suspect by those who require empirically reductionist approaches to establish truth On the other hand, his methodology, while subjective, involves and reports on people and events in the real world: rock climbers, chess players, dancers, surgeons, and the like. Csikszentmihalyi (1975) is interested in why they do (and keep on doing) the things they enjoy. What is there about the experience that keeps them engaged? His answer, "flow," is one of those words whose meaning, in this psychological context, is almost immediately understandable. We know what it is because we have experienced it ourselves and it represents truth to us as much as any empirical result from the lab.

But how can his theorizing provide guidance to designers of computer-based

interactive instruction? Malone (1981) lumps Csikszentmihalyi with others who see meeting challenge as the vital element in intrinsic motivation theory and faults him for ignoring the role of curiosity. Others (Keller, 1987) fault his work for being over broad and merely descriptive. This writer searched in vain for "curiosity" or "exploratory behavior" in the various indices of Csikszentmihalyi's work read for this paper. The answer, I think, lies not with his work or theories, but with our own approaches to learning and instruction.

At its most basic, Csikszentmihalyi's "flow" state is simply a description of people enjoying themselves. They are in a state of enjoyment because they have situated themselves in an environment that challenges them optimally. This should strike a responsive chord within the educator that should resonate, "That's how I want my students (and me!) to be in the classroom." It represents a desired state to strive for (i.e., an instructional goal!) for us as creators of educational environments. He has thoroughly documented his extensive work with many different populations, even across cultures (Csikszentmihalyi, 1990a). That flow states exist and are achieved regularly by people in all walks of life, at all times of day, at every age he has chosen to investigate, is well documented. If educators find it difficult to see possibilities for enjoyment in learning, flow states will seem foreign through no fault of Csikszentmihalyi's.

Besides being a particularly well described goal for educators (including CAI designers), flow also has the desired property of being "autotelic," i.e., it seems to reward itself. Much has been written about the desirability of intrinsic motivation vs. extrinsic motivation in learning that indicates its significance to educators (Day, et al., 1971; Lepper & Greene, 1978). Csikszentmihalyi's work is so representative of the field of intrinsic motivation his contributions have nearly become lost in it. Certainly Malone (and later Lepper and Malone) seemed to ignore the larger ramifications of flow states even as they proposed motivational strategies that could likely bring them about. Perhaps, again, there is some problem with seeing (and designing) learning as openly enjoyable.

Csikszentmihalyi does have much to say about the teaching/learning process and does so in several of the sources surveyed for this paper. In Play and Learning Csikszentmihalyi (1979) presented his flow theory to a group of early childhood scholars sharing views on the role of "play" in child development. While his work up to that time had involved only adolescents and adults, his flow theories found a ready and enthusiastic audience. The participants quickly adopted "flow" as synonymous with adult "play" and applied it to their own work with children and play. Csikszentmihalyi cautioned them "about the separation of play and 'real life,'" (p.269) making clear his position that play (children's flow) was life, just as adult flow was a real and genuine experience.

The "Flow Activities Room," a project applying Csikszentmihalyi's theories at Indianapolis' Key School (a magnet elementary school), provides a place for students to engage in and experience flow states through "structured play" and other coordinated activities (Cohen, 1991). In this room students are expected to engage in some purposeful activity that they enjoy. After a year long period of observation, a study (Whalen & Csikszentmihalyi, 1991) showed that students were able to describe fully their flow experiences and did so positively. They also demonstrated a marked preference for the flow room and its methods over their classroom subjects (also designed to be intrinsically motivating but, of necessity, more directed). The room and its activities were seen by the students as challenging but enjoyable. The learning that occurred there can only be related on an individual basis, but the authors conclude that the experience was clearly rich in individual and interpersonal growth.

Recently some investigators have begun to relate Csikszentmihalyi's work to human-computer interactions (Webster, Trevino, & Ryan, 1993). Studying the "playfulness" of students and (later) employees using various application software, the authors developed a

measure of flow. They found flow, in this context, had three dimensions: control, attention focus, and "enjoyment." The latter was a combination of curiosity and intrinsic interest.

In an essay meant to provide philosophical direction to educational reform, Csikszentmihalyi (1990b) states that "It is not that [U. S.] students cannot learn; it is that they do not wish to," (p. 115). His thesis is that technology and methodology will not educate students if they are not motivated to learn. After explaining flow, Csikszentmihalyi maintains that students can and do experience this state on occasion, and that educators need to actively promote its presence during instruction.

Since it is a naturally occurring state in someone engrossed in what they are doing, teachers must be wary imposing conditions that tend to discourage its occurrence. Citing Amabile (1983), Csikszentmihalyi (1991) says these conditions include: (1) excessive control, rules, procedures, time constraints; (2) emphasis on evaluation, rewards and punishments, norm referenced competition; (3) too much emphasis on "winning;" (4) making the individual self-conscious. These are all counter motivational, generally, and serve to reduce the exercise of the individual's intrinsic motivators and the likelihood of "flow" states occurring in the classroom. He concludes, "It is hoped that with time the realization that children are not miniature computing machines will take root in educational circles, and more attention will be paid to motivational issues" (p. 138).

Conclusion

The goal of this paper was two fold: Place the fuller version of curiosity theorizing into current thought regarding motivation for learning, particularly as is applies to the creation of computer-based interactive instruction; and relate these theories to the "flow" state theorizing of Csikszentmihalyi. With respect to "curiosity" the result has been to raise more questions than were answered. The death of Berlyne left the field without anyone to be the grand visionary. The result has been the near total subsumption of curiosity by the motivational psychologists, particularly those concerned with intrinsic motivation. Where intrinsic motivation and learning are discussed, curiosity and motivation become nearly one and the same.

Perhaps this is the best stance for those interested less in the (presently unknowable) biological mechanisms underlying cognition and impatient to get on with creating interactive learning environments. While cognitive science and neurobiology forge links and much is promised (Sejnowski & Churchland, 1989), we are left facing our students today. As reflective practitioners concerned with the whole person before us, we are prepared to incorporate as many useful "tricks of the trade" as are needed to foster learning. It is precisely at this viewpoint that Csikszentmihalyi's flow state theorizing becomes both a metaphor and a practical design goal for the types of instruction that will encourage learning, empowering us and our students to better understand each other and our world.

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